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SOIL-CONSERVING TILLAGE SYSTEMS FOR CORN



Farmers' Bulletin No. 2118

UNITED STATES DEPARTMENT OF AGRICULTURE

The Department of Agriculture and the State experiment stations are moving ahead with new research programs on tillage. It will pay you to keep in touch with this research work by consulting your county extension agent and the technicians of your soil conservation district. They can give you more information about the tillage methods described in this bulletin. They may know of farmers close to you who have tried them.

USDA Farmers' Bulletin 2073, Corn Production, contains additional information on some of these tillage methods and on corn production.

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SOIL-CONSERVING TILLAGE SYSTEMS FOR CORN

Conventional corn tillage systems have changed very little since the era of horse-drawn equipment. Land preparation includes early plowing, several diskings, and one or more harrowings with a spike-tooth or drag harrow. Corn is planted with a runner-type planter; cultivations with a shovel-type cultivator start early and are frequent.

Modern farming, however, has introduced changes that make some of these operations unnecessary. These changes include—

- Widespread adoption of hybrid corn that has high-yielding capacity and increased vigor.

- Increased use of fertilizer—particularly nitrogen and high analysis mixed fertilizer—which makes the crop less dependent on available soil nutrients.

- Chemical herbicides that eliminate the need for early and excessive cultivation.

- Insecticides that control insects harbored by plant residues.

- Tractor power and improved farm machinery that permit timing field operations to better fit soil moisture conditions.

Moreover, research is showing that excessive tillage can cause soil erosion, soil compaction, and undue loss of soil moisture. And since severe, erosion-causing storms are most likely to occur in late spring and early summer, some form of erosion protection for corn is especially important during seedbed preparation, planting, and the early growth stage of the crop.

Some Tillage Systems To Choose From

The following corn tillage systems offer farmers an opportunity to reduce the cost of growing corn and to do a better job of conserving soil and water. Tests show that, in many instances, yields for all systems have been about equal.

Each system is suited to specific soil conditions. No method is a “cure-all” for all conditions. Many farmers, however, should be able to pick a system to help them cut costs and reduce erosion.

Mulch tillage permits corn to be grown where the residue of the previous crop has been left on the

soil surface. It conserves soil and water.

Double-cut plowing, a variation of the mulch tillage system, turns over thin strips of sod and tills the soil beneath the sod to a depth of 6 inches. It is the best mulch tillage system known for growing corn following meadow or pasture.

Manure mulching is simply the practice of spreading manure on the seedbed either before or after the corn has come up.

Plow-plant eliminates some of the preplanting operations and helps control erosion because it

avoids pulverizing and packing the seedbed. There are several variations of the plow-plant system, all of which allow late plowing and immediate, follow-up planting of the corn.

Ridge-row tillage is a system whereby corn is planted on ridges of soil turned over on undisturbed soil. Ridge-row tillage was designed primarily for use on slow-draining soils and for holding back runoff on slopes.

Listing is the reverse of ridge-row tillage—that is, corn is planted in the bottom of furrows. It is one of the most rapid methods of getting a corn crop into the ground.

Corn-sod intercropping covers a number of practices—all designed to permit the seeding of grasses and legumes between corn rows. Spaces between corn rows are usually wider than the common 40- or 42-inch widths.

MULCH TILLAGE

Mulch tillage is best suited to well-drained, medium- to light-textured soils that warm up fairly rapidly in the spring. High levels of fertility, especially nitrogen and potash, are desirable. Mulch tillage is most valuable on sloping, erosive fields.

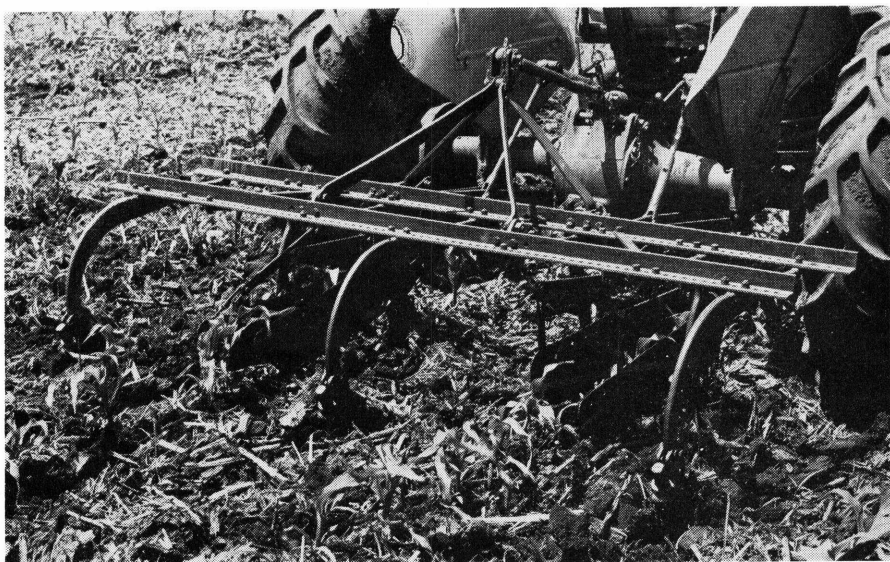
Mulch tillage is most successful on fields with a crop residue such as stalks of the previous corn crop, residue from small grain, or a winter annual cover crop.

This system is not well adapted to slowly drained soils. Moreover, mulch tillage may be unsatisfactory in a crop system where corn follows a perennial grass-legume sod, because it may be difficult to kill the perennial grasses, particularly in wet springs.

If you have pastured the corn-stalks or winter cover from the pre-



Tool bar cultivator operating in grain stubble. Equipped with 30-inch sweeps, this machine kills weeds, loosens soil, and leaves a mulch on the surface. (Courtesy of John Deere Co., Moline, Ill.)



This cultivator is especially equipped to operate through the residue left by the mulch tillage system. (Courtesy of Iowa State College.)

vious year's crop, there may be insufficient residue to give much erosion protection.

Procedures

Break up the residue with a stalk chopper or disk. Then till the soil to a depth of about 6 inches with a sweep plow, a heavy field cultivator, or any machine that will loosen the soil without turning it over. This operation tills the soil and kills weeds. Such tillage is frequently done in two operations, the first about 3 inches deep and the second about 6 inches deep.

Follow with a disk or a reversed rotary hoe or treader to break up the clods and to firm the seedbed if the surface is rough.

Plant the corn next. Attach a stub runner, rolling coulter, or disk furrow opener to the planter to cut through the residue.

At cultivation time, use a cultivator with disks near the row and large sweeps in the middle sections between rows. It may be necessary to use herbicide sprays for early weed control.

Machinery Needed

You will need the following pieces of machinery for tillage, planting, and cultivation:

1. A stalk chopper or other implement for breaking up residues.
2. A machine for loosening the soil to a depth of 6 inches without inverting it. These are called sub-surface tillers, sweep plows, chisel plows, rippers, or field cultivators.
3. A dish harrow, rotary hoe, or treader for breaking heavy clods.
4. A planter equipped with a stub runner, rolling coulter, or disk furrow opener. (If your land is

sandy, you may use a lister with narrow moldboards.)

5. A cultivator that will operate through the residue.

Advantages

The chief advantage of mulch tillage is improved soil and water conservation. Tests in the Corn Belt show losses of soil and water from mulch-tilled plots on sloping land are usually less than half such losses from corn plots prepared by the plow-disk-drag harrow method. In dry years, mulch tillage shows an advantage over plowing because it reduces water runoff and decreases evaporation.

When ample residue is present, mulch tillage often provides satisfactory erosion control on gentle slopes where corn follows corn, or on land cropped with corn-winter cover crop systems. Mulch tillage gives some erosion protection for off-contour row crops, although it is more effective when used on the contour. On sandy soils, surface residues help prevent soil blowing.

Disadvantages

It is more difficult to control perennial grass-type weeds under mulch tillage. Most residues used in mulch tillage tie up available soil nitrogen as they decompose. Therefore, more nitrogen fertilizer will be needed. Some soils also require more potash fertilizer. Soil temperatures are lower under mulches and corn may start off more slowly, especially in cool, wet seasons. Yields may be slightly lower under mulch tillage.

Special care is required in planting to make sure seed falls in firm, pulverized soil and that residues do not clog the planter.

Mulch on the surface may interfere with the flow of water down the furrows where corn is furrow irrigated.

DOUBLE-CUT PLOWING

Double-cut plowing is the best method of mulch tillage for the cropping system where corn follows perennial grass. Tests show approximately the same yield results from this system as from the plow-disk-drag harrow method.

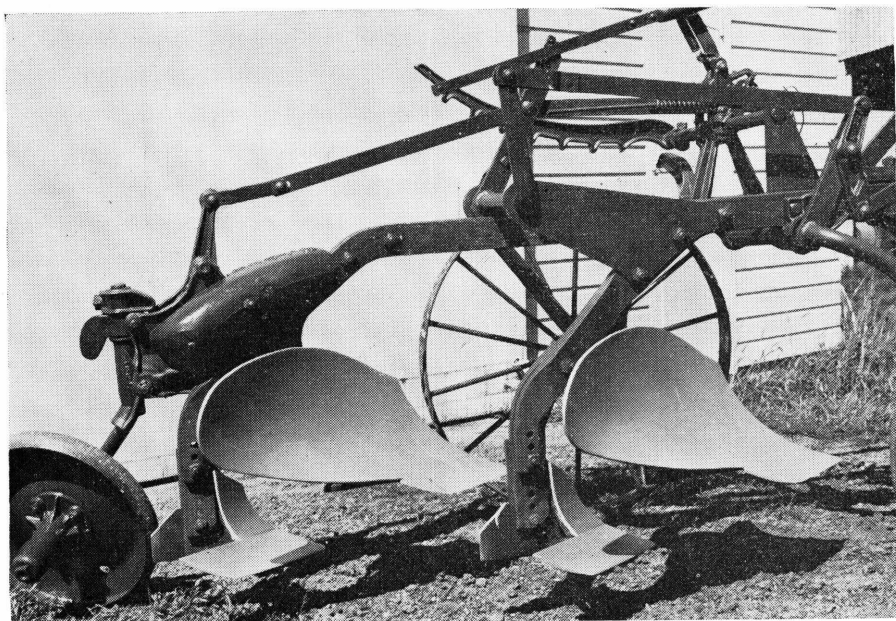
Procedures

Use a standard share and moldboard plow with a smaller share or sweep attached to operate behind the front share. Set the front share to run at a depth of 2 or 3 inches. Set the rear share to run 4 inches deeper than the front one.

After plowing with the double-cut plow, let the inverted sod lie for several weeks to help kill perennial grasses and legumes. Work the field one or more times during this period with a spring-tooth harrow or field cultivator. This pulls sod clumps to the surface for better mulching, breaks up clods, and helps kill the sod.

Plant and cultivate in the same manner as outlined for mulch tillage.

Double-cut plowing does not leave as much residue on the surface as mulch tillage with sweeps does, but it is more effective in killing perennial grasses and legumes.



A double-cut plow. The smaller shares are set to run 4 inches deeper than the larger ones

Machinery Needed

You will need the following pieces of machinery :

1. A double-cut plow (sometimes called a subsoil plow). You can make one by fitting rugged sweep attachments to a standard plow in such a way that they run behind and below the plowshare.

2. A spring-tooth harrow or field cultivator.

3. A planter with stub runners, rolling coulter, or disk opener for working through residue.

4. A cultivator that will work through residues. A rotary hoe is desirable for the first cultivation.

Advantages

The big advantage of double-cut plowing is improved control of water runoff and soil erosion. Early plowing is possible with this

method. This permits better timing of field operations on some farms.

Disadvantages

Land partially covered by pieces of sod warms up slower than when sod is turned under. Corn may be slow in starting, especially in cool, wet springs.

MANURE MULCHING

Apply well-rotted manure to the field with a manure spreader after the seedbed is prepared. You may apply the manure after the first cultivation of corn, but this practice may partly cover up or damage some plants.

Advantages

Well-rotted manure applied on the surface is more effective in sav-

ing soil and water than the same amount of manure plowed under. Ohio experiments show that surface-applied manure gives higher corn yields in dry years. On sandy soils, a manure mulch helps prevent soil blowing.

The work of spreading manure comes at a different time than for conventional tillage methods. This may be an advantage or a disadvantage depending on the farm work schedule.

Disadvantages

The cheapest method of handling manure on some farms, especially dairy farms, is to spread it almost daily. Stockpiling manure to provide a supply for mulching requires extra labor. On steeply sloping

land, it may be difficult to keep the manure-spreader wheels from slipping into the corn row and damaging the stand.

Manure used as a surface mulch may lose more nitrogen by volatilization than manure plowed under. Very strawy manure may cause a temporary tie-up of soil nitrogen.

PLOW-PLANT

Planting corn at the time the ground is plowed, or soon after, is one method of reducing the number of times over the field. It is best adapted for use on sandy to medium-textured soil in good physical condition. Clods may be so hard on fine-textured soils that effective planting and cultivating may be difficult. Use some sort of light,



A plot of corn growing under the manure mulch system. (Courtesy of Ohio Agricultural Experiment Station.)

secondary tillage just behind the plow on such soils.

These systems work well in northern States where wet soil delays preparation of land until near planting time, and where the planting season is rainy.

Procedures

There are several variations of the plow-plant method, all of which allow plowing to be done later than for conventional tillage systems.

1. Plant immediately after plowing. Set the planter to run in the tracks of the tractor pulling the planter. There is no other pre-plant tillage operation. The pulverizing action of the rubber-tired tractor wheels forms the required firm, pulverized zone around the seed.

2. Attach a planter directly behind the plow so that it plants on the side of one of the turned furrows. This plow-plant system was developed at Cornell University Experiment Station, New York.

3. Attach behind the plow a secondary tillage implement such as a spike-tooth harrow, rotary hoe, or cultimulcher. This system plows, smooths, and lightly firms the soil in one operation. Plant the corn soon after plowing. There is no other seedbed preparation.

If weeds are a problem, use a tine weeder, rotary hoe, or cultipacker for the first weed control operation when you are using these plow-plant systems. These machines break up the clods and bury the weeds between the rows. Weeds may not become a problem in some instances until the clods



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Corn being planted by the plow-plant system. The corn planter is set to run in the tractor wheel tracks.

have mellowed and the corn is 6 to 8 inches tall. Use a standard cultivator if weeds are not a problem.

Machinery needed

You will need the following pieces of machinery:

1. A moldboard plow.
2. A planter.
3. A tractor on which the wheels can be set at corn-row width. (*Note: The hazard of overturning a tractor on sloping land is greater when the wheels are set in.*)
4. An individual planter unit that can be attached directly behind the plow is needed if plowing and planting are to be done in the same operation. This planter requires a depth control runner on the planter shoe to firm the soil and provide uniform depth planting.
5. A tine weeder, rotary hoe, or cultipacker for weed control.

Advantages

Plow-plant systems cut costs by eliminating one or more steps in

seedbed fitting. These savings can run as high as \$10 an acre.

These systems give better control of soil erosion and water runoff during late spring and early summer because the soil remains loose and has a rough surface. There is also less wind erosion.

Plow-plant reduces the possibility of soil compaction or tillage pans.

Disadvantages

Plow-plant schemes delay plowing until corn-planting time. This delay may disrupt the spring work schedule.

Drought hazards may increase because the growing sod or winter cover crops will use moisture needed by the corn crop.

Planting corn in tractor tracks on fine-textured soil may cause hard

crusts in the planting row, especially if the soil is too wet. When the soil is too dry at planting time, seeds may get a poor start because soil particles often are too coarse for good soil-to-seed contact. Using a light soil pulverizer behind the plow will help, but this practice makes the field less resistant to erosion.

Two-row cultivation can be difficult if a one-row planter unit is used in the plow-plant system on contoured fields.

RIDGE-ROW TILLAGE

Tests in Iowa show ridge-row tillage has promise as a method for growing corn. (Ridge rows and raised beds have been used for tobacco and cotton culture in some Southern States for many years.)

Ridge-row tillage is especially adapted to slow-draining soils and



A field of corn planted by the ridge-row system.

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Constructing ridges with a double bottom two-way plow. (Courtesy of Iowa State College.)

to fields where slope conditions permit row layout to stay close to the contour. It is difficult to lay out ridge-row systems on fields with irregular or choppy slopes.

Procedures

Use a single bottom two-way plow to construct 10- to 12-inch ridges of loose soil turned over on top of an unplowed strip. (In plowed ground, use a disk-type bedder to make the ridges.) Plan the plowing so that soil ridges alternate with the furrows made by one pass of a single bottom plow. You can space ridges uniformly (standard corn-row width) by adjusting the spacing of the tractor wheels.

Apply a chemical herbicide spray to control weeds in ridge-row corn. Set your cultivator to move soil

toward the row. This maintains the ridges and helps control weeds.

Some preliminary experiments indicate that ridges, once built, can be used for the succeeding crop of corn by shredding the stalks and reshaping the ridges with a cultivator or disk hiller.

The ridge-row system may be varied by constructing wider ridges and planting two rows 40 inches apart on each ridge. These are built by making one round with a 2- or 3-bottom plow.

Machinery needed

You will need the following pieces of equipment:

1. A single bottom two-way plow or your regular plow plus a disk hiller for making ridges.
2. A tractor-mounted planter or a trailed planter equipped with disk guides to keep it on the ridges.

3. Weed spray equipment.

4. A cultivator with disks set to throw soil to the top of the ridge. The disk hiller can serve this purpose.

Advantages

In wet seasons and on slow-draining soils, corn growing on top of the ridge is less likely to suffer from poor soil aeration. Ridge rows on the contour hold back runoff from all but the very heaviest storms and thus decrease erosion.

Power costs for ridge-row tillage are usually less than for the plow-disk-drag harrow method.

The corn picker harvests a higher proportion of the down corn because the gathering points can get beneath more of the bent-over stalks. Also, it is possible to operate the tractor and other implements at higher speeds since the ridges act as guides.

Yields are about the same as for conventionally planted corn.

Disadvantages

Success of ridge-row tillage for corn depends on adequate weed control early in the season. Since it is difficult to cultivate until the corn is 12 to 15 inches tall, herbicides must be used.

Successive crops such as small grain or hay require leveling off the ridges after corn is harvested.

Another disadvantage is that soil compaction from tractor travel may occur in the furrows, particularly when the soil is wet.

LISTING

Listing is just the reverse of ridge-row tillage. It is best suited to well-drained soils in corn-producing areas, where rainfall is light. Listing has been a common practice for many years in the western part of the Corn Belt.

It is sometimes used on heavy, poorly drained bottom land simply because it is a fast method of getting corn planted. Under such conditions it is advisable to firm or pack the soil over the seed.

Plant listed corn only on fields where the slope permits the rows to follow the contour closely. Listing is not adapted to irregular or choppy slopes.

Procedures

There are two types—"hard ground" listing and "loose ground" listing.

In hard ground listing, use a lister or middlebuster with a corn planter attached. The lister opens a furrow and throws the soil to each side. Corn is planted in the bottoms of the furrows.

On heavy soils and when the soil is quite moist at planting time, it may be desirable to pull a rubber-tired packer over each row a day or so after planting. This firms the soil around the seed.

Cutting or shredding the stalks usually precedes hard ground listing where corn follows corn. Hard ground listing works well following corn, small grains, or soybeans.

In loose ground listing, plow the field in the usual way before plant-

ing. Use disk furrow openers on the planter for making the furrows and ridges. Loose ground listing works best following sod crops.

Begin weed control early by cultivating with a harrow or rotary hoe. Later, use a regular cultivator for breaking down the ridges and hilling up the corn. The second operation also buries the weeds in the row.

Machinery needed

For hard ground listing, you will need the following pieces of machinery:

1. A lister or middlebuster with

planter boxes attached. Two-row machines are usually used.

2. A drag harrow or rotary hoe for early weed control.

3. A cultivator with disk hillers set near the row for later cultivation. Cultivators especially designed for listed corn are used in the western part of the Corn Belt.

For loose ground listing, you will need the following equipment:

1. A plow.

2. A conventional planter with disk furrow openers (used in place of the lister planter).

3. Weed control equipment as above.



Corn being planted by the "loose ground" listing system. Note the furrow openers attached to the corn planter. (Courtesy of International Harvester Co.)

Advantages

One big advantage of hard ground listing is that it's a once-over operation. It combines seed-bed preparation and planting.

Hard ground listing requires less tractor work and time than plow-disk-drag harrow methods. Hard ground and loose ground listing holds back runoff water when rows are planted on the contour. This conserves soil and moisture. It also helps prevent young corn from being cut off by blowing soil. Listed corn planted in western Iowa has outyielded corn grown by customary methods.

Disadvantages

Heavy, dashing rains that come soon after planting may drown corn or cause the furrows to "silt in." This condition may delay seedling emergence or even bury young corn. "Silting in" is most common on soils containing a low percentage of organic matter and on soils of poor physical condition.

Listed corn usually starts off more slowly in cool seasons than surface-planted corn. Using starter fertilizer helps overcome this condition.

Listed corn washes out more readily during heavy rains than surface-planted corn.

Another disadvantage is that during the first cultivation, careful operation is necessary to keep the tractor on the ridges.

CORN-SOD INTERCROPPING

Corn-sod intercropping is especially adapted to the northern Corn Belt, where drought is not

common. Stands of legume-grass seedlings in wide-row corn have failed in dry seasons in the western part of the Corn Belt.

Corn-sod intercropping is also adapted to northern Corn Belt farms where long rotations (1 year of corn + 2 to 3 years of meadow) are used on steep land. This plan allows growing the corn and renovating the sod with little danger of soil erosion.

Procedures

Intercropping corn with grasses or legumes requires that the corn rows be widened to allow light to fall on the new seedlings. Most common spacings are 60-, 80-, or alternating 40- and 80-inch rows. A method developed by the Ohio Experiment Station gets the same results by spacing hills of corn at long intervals in standard-width corn rows.

You may combine intercropping with minimum tillage. Plant the corn in 60- or 80-inch rows in the tractor tracks on freshly plowed ground. After 1 weeding and 1 cultivation, band seed a grass-legume mixture between corn rows with a drill or packer seeder. Use either a small seeder—narrow enough to operate between the rows—or a regular seeder with gaps to permit row straddling. If you plan to harvest the intercrop seedling for hay the following year, it is best to cut the corn for silage so cornstalks will not interfere with the first cutting of hay.

Make your intercrop seeding between the rows soon after corn is planted. If weeds become a prob-



Alfalfa and red clover interseeded between 80-inch corn rows. Photo taken near Independence, Iowa, in 1953. (Courtesy of Iowa State College.)

lem, use a narrow rotary-type mower between the rows.

Other variations of corn-sod intercropping are designed to permit a living strip of old sod to remain between the wide-spaced corn rows for a part of the season, or to allow early seeding of winter wheat in the wide rows before corn harvest.

Machinery Needed

Machinery requirements for the different methods vary, but in general you need the following equipment:

1. A planter suitable for a selected row width.
2. A packer seeder or drill seeder with press wheels that will work between the rows or straddle them. A seeder that bands the fertilizer close to the seed is desirable.

3. A rotary mower for weed control between the rows.

4. A single-row picker or silage harvester.

Advantages

Corn-sod intercropping provides good control of soil erosion and water runoff. It may permit cutting down on the acreage of spring oats, a common nurse crop for seedings of grasses and legumes. Actually, wide-row corn yields can bring more income than yields from the same acreage of spring oats. More timely planting of winter wheat may be possible with the wide-row corn system.

Disadvantages

The biggest objection most farmers have to corn-sod intercropping

is the necessity for more specialized machinery than is required for other tillage systems. Research agencies and machinery manufacturers, however, are developing equipment that should make the system easier to adopt.

Corn yields are less with wide rows than with standard rows. There is also the chance that in dry years, stand failure of legume-grass seedings will be more common

than in spring oats. Moreover, stalks or corn stubble may interfere with the first hay harvest.

Keep in mind that you actually have two crops growing on the same land when you use corn-sod intercropping. Without sufficient moisture and plant nutrients, one or both crops will suffer. In many areas it may be advisable to grow each crop separately.

How To Select a Tillage System

The tillage system you choose must fit in with the cropping system or rotation used on your farm and the kinds of soils.

When you plan for a change in tillage practice for corn, consider first the way you handled last year's crop residue. (For example, mulch tillage is not effective where stalks or other residue have been pastured off closely before planting time.) Then plan each step through seed-bed preparation, planting, early

weed control, cultivation, harvesting, and getting ready for the succeeding crop.

Figure out the timing of various operations and check this against the labor and machinery that will be needed for other farm operations at the same time. Planning the tillage system should also take into account how and when you will apply needed fertilizers. The best time of application and the placement of fertilizer will vary among the different systems.

Other Recommended Practices

Keep in mind that a good tillage system in itself does not guarantee efficient corn production. Plant adapted hybrid varieties; use recommended fertilizers; and plant at a rate that will insure a stand thick enough to make full use of available moisture and fertility.

If rootworms, corn borers, or cut-

worms, are a problem, control them with chemicals. Apply chemical herbicides at recommended rates in all cases where their use is a part of the plan.

High yields of corn, better erosion control, and low costs of production are the result of many practices used together.